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AN AIR POLLUTION EPISODE IN THUNDER BAY.

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An air pollution episode in
Thunder Bay : Griffin, Dennis.

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AN AIR POLLUTION EPISODE

in

THUNDER BAY

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NORTHWESTERN REGION
ONTARIO MINISTRY OF THE ENVIRONMENT

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INTRODUCTION

Thunder Bay, population 115,000, is normally considered to be a city with good air quality. Historically, the grain elevator industry caused elevated dust concentrations in Thunder Bay, but this problem was resolved about 10 years ago. Currently, the only industrial air emissions of note are from four pulp and paper mills and a 200-megawatt thermal power plant. These sources are small, however, compared with many similar facilities elsewhere. Other sources of air pollutants include vehicles, space heating, a few small industrial boilers, and urban construction.

The Ontario Ministry of the Environment operates an air quality monitoring network in Thunder Bay. The network comprises a main monitoring site (station 63200), where several air pollutants are continuously monitored, plus subsidiary sites for the measurement of total reduced sulphur (TRS) and particulate matter. The locations of these monitoring points, plus those belonging to Ontario Hydro, are shown in Figure 1.

In addition to data for several pollutants, station 63200 generates an air quality index (AQI) for Thunder Bay. The AQI, calculated hourly, is based on the pollutant with the highest hourly sub-index. The index is divided into categories of very good, good, moderate, poor, and very poor.

The AQI has been published since June, 1988. Between then and the date of the episode described in this memorandum, the AQI reached the moderate category once in 1988, 4 times in 1989 and 11 times in 1990. The occurrences of moderate AQI in 1988 and 1989 (5 hours in total) were caused by TRS emissions from Canadian Pacific Forest Products Ltd. In 1990, however, 10 of the 11 moderate AQI readings were due to suspended particles. Until November 30, 1990, all but one of the occurrences of moderate AQI were each of one hour duration. Moderate AQI was recorded for 2 hours on November 8.

THE EPISODE

On November 30, 1990, the levels of several pollutants at Thunder Bay's AQI station increased significantly shortly after 7:00 a.m., eastern standard time. Suspended particles (COH), nitric oxide (NO) and carbon monoxide (CO) showed the sharpest increase (Figures 2 and 3). Nitrogen dioxide (NO_2) increased moderately, while sulphur dioxide (SO_2) and TRS rose slightly. Ozone (O_3) remained at or near zero. Elevated pollutant readings persisted until just after 2:00 p.m., when concentrations returned to background levels.

Table 1 presents the hourly average concentration of several pollutants and wind data at the AQI station, plus TRS at station 63046. The monitor at station 63046 measures community levels of TRS near Canadian Pacific Forest Products Limited. As Table 1 shows, winds were calm when pollutants were elevated.

In Table 2, the AQI values during the November 30 episode are listed. As indicated, the AQI was in the "moderate" category for four hours, reaching a maximum of 43. The "poor" air quality category begins at 50.

At 7:00 a.m., there was a low pressure area over central Manitoba, with a warm front extending southeast to a point just north of Sioux Lookout, Ontario, then south-southwest into Minnesota. This front was moving east-northeast, towards Thunder Bay, and was associated with south-southwest wind behind and ahead of the front. However, winds in the south end of Thunder Bay were calm at the time, sheltered by Mount McKay and the Nor'wester range of hills.

During the beginning of the November 30 episode, Thunder Bay air temperature was about -9°C, compared with -2 to -4°C in the area to the south and west. The southwest wind associated with the advancing warm front was therefore moving mild air into Thunder Bay over high ground at the south end of the city. The cold air which had developed overnight in Thunder Bay became trapped below the advancing warm air. These conditions permitted an increase in air pollutants over a period of several hours. During this time, a low-lying, yellowish-brown haze was clearly visible over the southern part of the city.

THE POLLUTION SOURCE

The decline in air quality on the morning of November 30 was not attributed to industrial sources. Emissions from the two largest sources near the AQI station impact air quality in very different, characteristic ways from the situation found on November 30. The thermal generating station (Ontario Hydro) sometimes results in modest increases in SO_2; the nearby pulp mill (Canadian Pacific Forest Products) occasionally results in slightly elevated SO_2 and TRS. The latter source, on November 30, was not operating due to an ongoing labour strike.

Having discounted local industry as the pollution source, the remaining possibilities included space heating and vehicle emissions. Space heating would contribute to NO and NO_2 levels, but would account for only a small proportion of the observed increase in the other pollutants. We believe that vehicle emissions best explain the pattern of pollutant concentrations recorded. TRS, slightly elevated at both the AQI station and at station 63046, is attributed to hydrogen sulphide emissions from catalytic convertors on vehicle exhaust systems. Emissions from school buses and other vehicles in the parking area at a school near the AQI station probably accounted for a substantial portion of elevated pollutant readings. However, the occurrence of TRS at station 63046 in similar concentrations as found at the AQI station suggests that emissions arose from a wide area.

THE EFFECTS

Although nitric oxide showed the most dramatic increase in concentration on November 30, it has no known adverse effects at the levels recorded. At a maximum of 8 pphm (parts per hundred million), NO_2 was well below the ambient 1-hour air quality objective of 20 pphm. Assuming that TRS was present as hydrogen sulphide, the maximum concentration of 4 parts per billion would not exceed the odour threshold for the average person, and is well below the objective of 20 ppb. SO_2 was well below the maximum acceptable limit of 25 pphm. CO reached 50% of the allowable limit of 30 parts per million. Only COH, with a 24-hour average of 1.0 COH units, reached the upper limit for desirable air quality.

Of all the pollutants whose concentrations increased on November 30, only suspended particles (measured as COH) reached a level high enough to cause a measurable effect. At a level between 2.0 and 3.9 COH units, which occurred for four hours, the expected effect on air quality is "some decrease in visibility." This is exactly the impact that was noted. No health-related or other effects would be expected.

FUTURE EPISODES

Under conditions of temperature inversions, the accumulation of vehicle emissions near the ground cannot be avoided. With present technology, a radical reduction in vehicle emissions is not currently practical. Therefore, in Thunder Bay we can expect occasional recurrences of episodes like the one on November 30, 1990. Fortunately, the impact of such events (temporary reduced visibility) is not severe.

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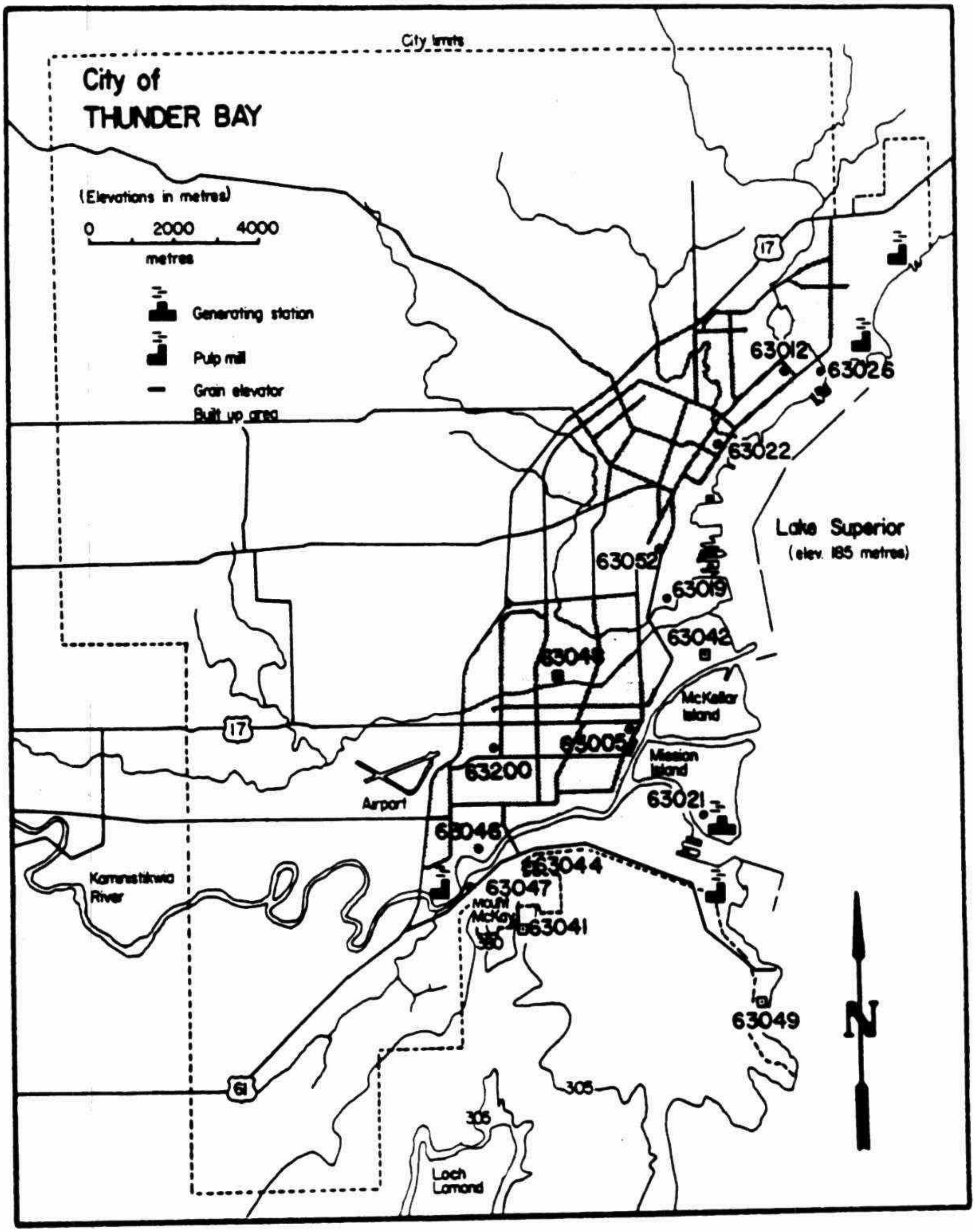

Figure 1. Air quality monitoring sites, Thunder Bay.

(▣ Ontario Hydro sites)

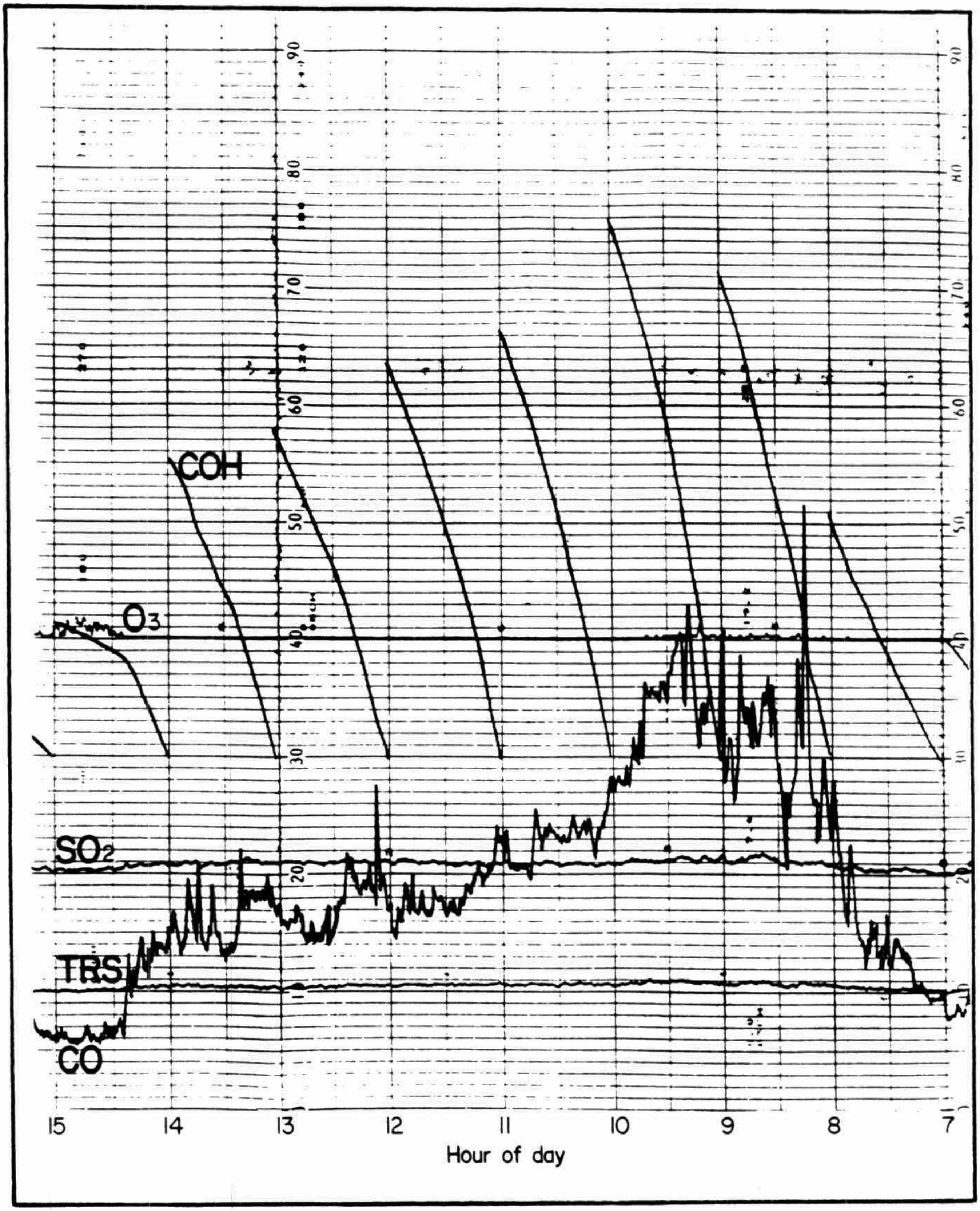

Figure 2. Concentrations of carbon dioxide (CO), total reduced sulphur (TRS), sulphur dioxide (SO_2), suspended particles (COH) and ozone (O_3) at station 63200, Thunder Bay, November 30, 1990.

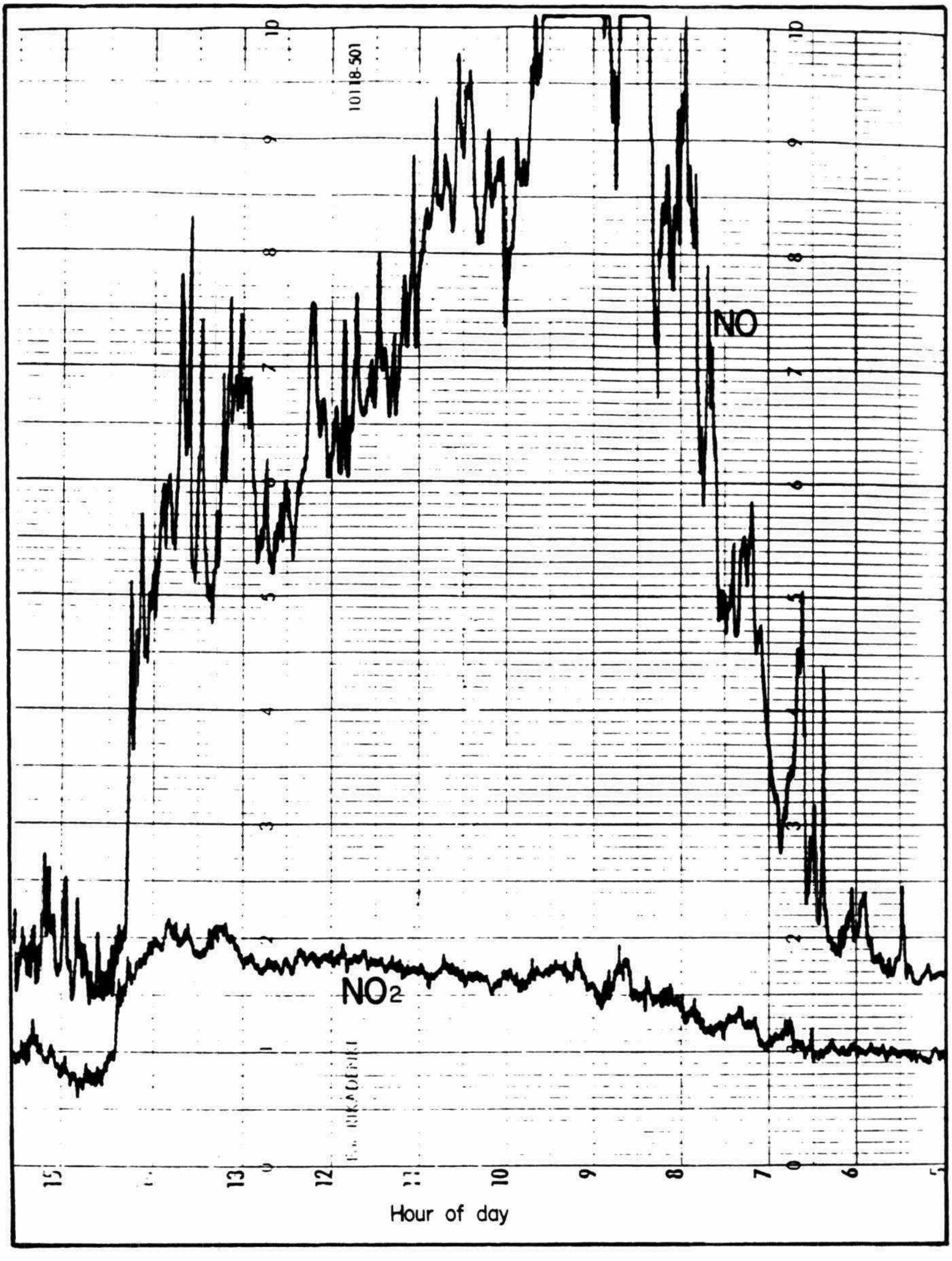

Figure 3. Concentrations of nitric oxide (NO) and nitrogen dioxide (NO_2) at station 63200, Thunder Bay, November 30, 1990.

TABLE 1. Levels of selected parameters at stations 63200 and 63045, Thunder Bay, November 30, 1990.

	Station 63200						63046	63200	
Time[a]	COH[b]	CO[c]	NO[d]	NO$_2$[d]	SO$_2$[d]	TRS[e]	TRS[e]	WS[f]	WD[g]
06:00	0.6	1	4	3	0	0	0	2	26
07:00	0.7	1	9	3	0	0	0	1	34
08:00	1.4	5	21	4	0	2	1		C[h]
09:00	2.8	13	42	5	1	4	3		C
10:00	3.2	15	47	6	1	4	3		C
11:00	2.5	9	38	6	0	3	4		C
12:00	2.3	7	31	7	0	3	4	2	19
13:00	1.9	6	25	7	0	2	3	1	11
14:00	1.8	6	26	8	0	2	2		C
15:00	0.8	2	11	4	0	1	0	3	212
16:00	0.5	1	4	2	0	0	0	6	217

[a] Eastern standard time
[b] COH units
[c] Parts per million
[d] Parts per hundred million
[e] Parts per billion
[f] Wind speed, kilometres per hour, 10 metres
[g] Wind direction, degrees, 10 metres (direction unreliable at speeds below 5 kph).
[h] C = calm

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TABLE 2. Air quality index (AQI) at station 63200, Thunder Bay, November 30, 1990.

Time	AQI	Highest pollutant	Category
06:00	9	API[a]	Very good
07:00	10	COH	Very good
08:00	22	COH	Good
09:00	39	COH	Moderate
10:00	43	COH	Moderate
11:00	36	COH	Moderate
12:00	35	COH	Moderate
13:00	31	COH	Good
14:00	29	COH	Good
15:00	25	CO8[b]	Good
16:00	23	CO8	Good
17:00	15	CO8	Good

[a] API = Air pollution sub-index (SO_2 and COH combined).
[b] CO8 = Running 8-hour average of CO.

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